PO7872
LeA 35,956

THERMOPLASTIC HEAT EXCHANGER

CROSS REFERENCE TO RELATED PATENT APPLICATION

The present patent application claims the right of priority under 35 U.S.C. §119 (a)-(d) of German Patent Application No. 102 53 852.2, filed November 19, 2002.

FIELD OF THE INVENTION

The present invention relates to a heat exchanger that includes a plastic base member and at least one plastic sheet thereover, wherein channels in each of the base member and the plastic sheet(s) together define at least one closed conduit (e.g., a meandering conduit) through which a heat transfer medium flows.

BACKGROUND OF THE INVENTION

The use of thermoplastic materials instead of metals for the construction of heat exchangers provides both enormous flexibility with regard to forming and shaping, and also improved resistance to corrosion thereof. Further advantages of plastic heat exchangers include reduced weight and improved impact absorption properties, which makes them particularly suitable for use in automobile construction.

Due in part to the low thermal conductivity of plastic materials, known plastic heat exchangers typically have an undesirably large heat exchanger surface, for example in the form of tubes or plates (which takes up too much space), and/or a low material thickness of the exchange surfaces (which can result in failure of the exchanger).

SUMMARY OF THE INVENTION

An object of the invention is to provide a simply constructed heat exchanger whose production is more cost-efficient than is possible with conventional structural shapes. In addition, on account of increasing complexity of the structural spaces that are available, a further object is to integrate the heat exchanger into existing plastics structural parts such as for example: in vehicles, e.g., air filter housings, suction units, valve covers, cooling units and oil sumps; or in data systems technology, e.g., housings, printed circuit boards etc.; or in ventilation technology. A further object is to provide a heat exchanger that allows for the extraction of heat from decentralized local heat-emitting centers, such as for example within electronic circuitry, electromechanical drives, fuel cell drives etc.

In accordance with the present invention, there is provided a heat exchanger comprising:

(a) a base member of thermoplastics material having an upper surface and a lower surface;

(b) at least one of,

(i) an upper sheet of thermoplastics material superposed over said upper surface of said base member, and

(ii) a lower sheet of thermoplastics material superposed over said lower surface of said base member;

(c) an inlet pipe, which provides an inlet for a heat transfer medium into said heat exchanger; and

(d) an outlet pipe which provides an outlet for said heat transfer medium from said heat exchanger;

wherein at least one of,

(i) at least one of said upper surface of said base member and said upper sheet has a channel therein, the upper surface of said base member and said upper sheet together defining an upper conduit, and

(ii) at least one of said lower surface of said base member and said lower sheet has a channel therein, the lower surface of said base member and said lower sheet together defining a lower conduit, and

further wherein said inlet pipe and said outlet pipe are in fluid communication with at least one of said upper conduit and said lower conduit.

The features that characterize the present invention are pointed out with particularity in the claims, which are annexed to and form a part of this disclosure. These and other features of the invention, its operating advantages and the specific objects obtained by its use will be more fully understood from the following detailed description and accompanying drawings in which preferred embodiments of the invention are illustrated and described.

Unless otherwise indicated, all numbers or expressions, such as those expressing structural dimensions, quantities of ingredients, etc. used in the specification and claims are understood as modified in all instances by the term "about."

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Figure 1 is a representative sectional view of a portion of the heat exchanger of Figure 2 along line A-A; and

Figure 2 is a representative perspective view of a partially sectioned heat exchanger according to the present invention.

In Figures 1 and 2, like reference numerals designate the same components and structural features.

DETAILED DESCRIPTION OF THE INVENTION

The heat exchanger of the present invention may be advantageously designed in the form of numerous three dimensional shapes. The design flexibility associated with the heat exchanger of the present invention derives in part from the method by which it is made, which involves injection molding of thermoplastics, thermoforming of thermoplastic sheets, and laser welding, as will be discussed in further detail herein.

The heat exchanger may include upper 6 and/or lower 6' conduits. The upper and lower conduits may each be in fluid communication with the same or separate inlet and outlet pipes. The upper and lower conduits may be separate from each other (i.e., in which case they are not in fluid communication with each other, and no cross-over of heat exchange medium occurs there-between). In an embodiment of the present invention, the heat exchanger includes separate upper and lower conduits that are each in fluid communication with a separate set of inlet and outlet pipes.

In a particularly preferred embodiment of the present invention, the heat exchanger (as depicted in Figure 2) includes both an upper conduit 6 and a lower conduit 6', and the base member 1 has at least one aperture 10 therethrough which provides fluid communication between the upper 6 and lower 6' conduits. The upper conduit 6, the lower conduit 6' and the aperture 10 together form a continuous conduit 20 through the heat exchanger. The inlet pipe 4 and the outlet pipe 9 are each in fluid communication with the continuous conduit 20.

The channels (7, 7' and 8, 8') in base member 1, upper plastic sheet 3 and lower plastic sheet 3' may each have cross-sectional shapes selected independently from, for example, semicircular, semielliptical, and semi-polygonal (e.g., semi-square, -rectangular, -pentagonal, -hexagonal, etc.).

Preferably, the channels have semi-circular cross-sectional shapes. Accordingly, the upper and lower conduits (6, 6'), that are defined by the combination of channels in base member 1 and the plastic sheets (3, 3'), may have cross-sectional shapes that represent any combination of the above recited cross-sectional channel shapes (e.g., circular, elliptical, pentagonal, and combinations thereof, such as partially circular and partially pentagonal). Preferably, the upper and lower conduits (6, 6') have circular cross-sectional shapes.

In a preferred embodiment of the present invention, each of the surface (e.g., the upper surface) of the base member and the sheet (e.g., the upper sheet) superposed there-over, have a channel therein, in which case the conduit (e.g., the upper conduit) is defined by alignment of the two channels. Alternatively or in addition thereto, only one of the surface (e.g., the upper surface) of the base member and the sheet (e.g., the upper sheet) superposed there-over, has a channel therein, in which case the conduit (e.g., the upper conduit) is defined by a single channel and an opposing surface, rather than by an alignment of two separate channels. For purposes of illustration, the upper conduit in this alternative embodiment is defined by either: (i) a channel in the upper sheet and the flat upper surface of the base member; or (ii) the flat surface of the upper sheet (opposing the upper surface of the base member) and the channel in the upper surface of the base member.

In a preferred embodiment, at least one of the upper conduit, the lower conduit and the continuous conduit runs in a meandering manner on the upper side and/or lower side of the base member.

In a likewise preferred embodiment, the upper conduit, the lower conduit and the continuous conduit (as the case may be) each independently have a cross-sectional area, in particular when using liquid media, of 1 to 200

mm^2 and, in particular in the case of gaseous media, of 1 to 500 mm^2.

In yet a further preferred embodiment the upper and lower thermoplastic sheets each independently have a thickness of from 0.05 to 1.5 mm.

The thermoplastic material of the base member, the upper sheet and the lower sheet may each be independently selected from at least one of polyamide (e.g., polyamide 6.6 or polyamide 6), polycarbonate (PC), polyalkylene terephthalate, in particular polybutylene terephthalate (PBT), acrylonitrile / butadiene / styrene copolymer (ABS), polyethylene (PE), polypropylene (PP), polytetrafluoroethylene (PTFE), thermoplastic polyurethane (TPU), polyvinylidene fluoride (PVDF) and thermoplastic elastomer (TPE).

For the supply and removal of the heat transfer medium the inlet pipe and outlet pipe are each preferably continuous with (e.g., joined as one piece to) the base member.

A particularly preferred use of the present invention involves a combination of the heat exchanger with a vehicle molded part, for example an air collector of a vehicle engine, which is produced from thermoplastics material (e.g., PA 66) by a shell technique. In this case the base member is a vehicle molded part, for example an air collector of a vehicle engine. Meandering channels are formed for example on the inside of the molded part. A sheet formed in such a way as to promote flow, i.e. with channels therein, is welded on to the molded part by laser welding, thereby forming a conduit defined by the channels in the vehicle molded part and the sheet. The connections for the heat exchanger, i.e. the inlet pipe and outlet pipe, are formed as part of the outside of the molded part. In this way a heat exchanger integrated into the air collector of a manifold pipe is formed, and which matches the flow-promoting three-dimensional shape of

the manifold pipe. The special cooling effect arises in this case due to the fresh air of the engine manifold flowing at high velocity over the surface of the heat exchanger. The cooling effect that is thereby obtained may be used to cool the engine control electronics (e.g., the electronics housing may be fitted out with the same segment).

This example illustrates a particular advantage of the present invention. By the use of a single sheet, optionally having channels therein, and the skilful shaping of an existing structural part (e.g., an air collector) for use as a base member of the heat exchanger, optionally having channels therein, a highly efficient heat exchanger can be provided within an extremely small space.

In further accordance with the present invention, there is also provided a method of preparing the heat exchanger, which includes:

(a) forming the base member (1) by means of injection molding;

(b) forming each of the upper (3) and lower (3') sheets by means of vacuum forming;

(c) contacting at least one of,

  (i) the upper sheet (3) with the upper surface (23) of the base member (1), and

  (ii) the lower sheet (3') with the lower surface (26) of the base member (1); and

(d) fixedly joining at least one of the upper sheet (3) and the lower sheet (3') to the base member (1) by means of laser welding.

The laser welding of the plastic sheet(s) (3 and/or 3') to base member 1 may be performed in accordance with art-recognized procedures. The plastic sheets may be laser welded to base member 1 at numerous points over their surfaces. Preferably, at a minimum, the plastic sheets are laser

welded to base member 1 at points that are proximate to the upper and lower conduits (6, 6'). With reference to Figure 1, the heat exchanger has laser weld points 5 that run along both sides of each portion of the upper 6 and lower 6' conduits.

In an embodiment of the present invention, the plastic sheets (3 and/or 3') are further fixedly joined to base member 1 by means of adhesives (not shown), in addition to the laser welding. The adhesives may be selected from those that are known to the skilled artisan. The invention is described in more detail in the following example with further reference to Figures 1 and 2.

EXAMPLE

The planar base member 1 of the heat exchanger has on both the upper surface 23 and the lower surface 26 meandering channels 7 and 7' of semicircular cross-section as well as an inlet pipe 4 and outlet pipe 9 for the supply and removal of a heat transfer medium (not shown). The meandering channels 7, 7' of upper surface 23 and lower surface 26 (and accordingly the upper 6 and lower 6' channels associated therewith) are in fluid communication by means of aperture 10 in base member 1. In this way the heat transfer medium can flow on the upper side as well as on the lower side of base plate 1. base member 1 was produced by an art-recognized injection molding method. Upper and lower vacuum-formed sheets 3 and 3', each having a thickness 0.4 mm, and each having a meandering channel 8 and 8' of semicircular cross-section were laser-welded to the upper side 23 and lower side 26 of base member 1. Base member 1, upper sheet 3 and lower sheet 3' were each fabricated from polyamide 6.6.

The channels 8 and 8' of the upper and lower plastic sheets (3 and 3') each form a counterpiece to the channels 7 and 7' of base member 1, so

that when the two molded parts are welded together the channels 7, 8 and 7', 8' lying on top of (aligned with) one another form upper and lower closed (continuous) conduits 6 and 6' through which a heat transfer medium flows (not shown).

The cross-section of the conduit 6 is about 20 mm. The heat exchanger may be mounted in an automobile engine compartment and may be operated with a 1:1 water/glycol mixture as a heat transfer medium. The size (Length x Width x Height) of the heat exchanger in the example may be about 150 x 100 x 15 mm.

Although the invention has been described in detail in the foregoing for the purpose of illustration, it is to be understood that such detail is solely for that purpose and that variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention except as it may be limited by the claims.